

The roles of physical mixing and biochemical composition on the depositional characteristics of flocculated suspended sediment in the Eden Estuary, Scotland

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Sediment load in estuarine waters is generally composed of a mixture of sand, clay and biological matter and it is recognised that there is strong mediation of the physical behaviour of sediment by biological components of the system (Paterson *et al.*, 2000). However the complex flocculation dynamics of this variable material still poses problems for the prediction of transport pathways and depositional behaviour of mixed sediments (Manning *et al.*, 2013). Therefore, understanding the physical and biochemical characteristics of suspended sediment during tidal immersion is of paramount importance when considering transport and deposition in these dynamic environments.

In intertidal mudflats, benthic microalgae can contribute up to half the total autotrophic production in an estuarine system (Underwood and Kromkamp, 1999). The extracellular polymeric substances (EPS) produced by both benthic and pelagic bacteria and algae are a key variable known to influence flocculation processes (Manning *et al.*, 2013). Variation in the nature and concentration of the EPS can alter sediment stability and erosion in mixed sediment beds (Taylor *et al.*, 1999; Black *et al.*, 2002) but these substances can also significantly enhance inter-particle cohesion in the water column and therefore deposition and transport.

This study examined the variation in naturally occurring EPS concentration as well as the composition of sugars and its influence on several physical variables of flocs within the Eden Estuary, Scotland. Samples were collected at 15-30min intervals over a full tidal cycle for total suspended sediment and colorimetric analysis of polymer concentration. Subsamples were transferred to the settling column of the LabSFLOC-2 (Laboratory Spectral Flocculation Characteristics 2), high resolution video floc camera system (Manning, 2006) *in situ* where settling flocs were viewed (resolution~10µm) to determine floc size (D) and settling velocity (Ws) characteristics. Additionally, further biochemical analysis of the carbohydrates of the EPS were performed by Gas Chromatography-Mass Spectroscopy (GC-MS) in order to assess the composition of monosaccharides within the samples and linkages.

Preliminary results indicate a wide range of microfloc (D< 160µm) and Macrofloc (D>160µm) fractions present, with the latter approaching 1mm during flocculation conducive conditions. Correspondingly, when considering all floc samples, floc settling velocities generally spanned three orders of magnitude with floc size and settling velocities correlating with polymer concentrations. These typically ranged from slow settling (Ws of 0.01-0.05mm.s⁻¹) predominantly organically based microflocs to faster settling, significantly larger and more porous Macroflocs settling at ~10-15mm.s⁻¹. The temporal distributions of D and Ws, sediment and polymer concentrations and sugar fractions, are examined in the paper with variation also related to physical and microbiological factors in the bed and the phase of the tidal flow. The relationship between the forcing factors, the bed condition and the source and sinks of EPS material are discussed. The results demonstrate the importance of understanding biological variation in the assessment of sediment transport pathways in estuaries.

References

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